A BASE measuring apparatus, which has been perfected in connection with the summer school work of the Civil Engineering Department of the Massachusetts Institute of Technology, has recently been tested by the Coast and Geodetic Survey in Washington. Such satisfactory results have been already obtained that the apparatus is about to be used in the important Lampasas Base in Texas. Prof. Burton, of the Institute, under whose direction the apparatus has been worked out, has been invited to accompany the expedition, which is to make a careful trial of the method in the field and upon extended exact work. The apparatus represents the final results of thesis investigations by several graduates of the course in civil engineering who have worked upon it in successive years. One part of the apparatus maintains a constant tension in the steel tape while in use. Another part of the apparatus determines very accurately the mean temperature of the tape by measuring its electrical resistance by means of a special form of thermophone devised by two graduates.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, December 14.—Meeting held at the Royal College of Science (by invitation of Prof. Rücker), Principal O. J. Lodge, President, in the chair.—A paper on electric inertia and the inertia of electric convection was read by Prof. A. Schuster. Calculations of self-induction are based on the assumption that the currents which traverse a conductor fill it continuously, the flow being treated as that of an incompressible liquid. The assumption is generally recognised not to hold in the case of electrolytes where electricity is conveyed by a number of irregularly distributed ions. In the immediate neighbourhood of such an ion, the magnetic field is many times greater than that calculated on the supposition of continuous distribution, and hence the total magnetic energy is underestimated. What is universally recognised in the case of electrolytes must also be conceded when the current is conveyed by a gas, and the idea is gaining ground that even in solid conductors the current consists of positive and negative electrons moving with different velocities. It is the object of the paper to calculate the additional terms which become necessary for the evaluation of self-induction, and to discuss the possible cases in which the corrections may effect experimental results. The mathematical investigation shows that it is necessary to add a correcting term containing a quantity which may conveniently be called electric inertia. The author has calculated the numerical value of this quantity in the case of a solid conductor, and finds it to be about 2×10^{-12} C.G.S. units. It is of the dimensions of a surface. The experiments of Hertz have proved that if electric inertia exists, it must be less than 18×10^{-8}. In the case of liquids and gases, the electric inertia of the moving ions becomes much more important, and the calculation of self-induction by the ordinary processes gives erroneous results. The introduction of a term representing inertia alters the general equations of electric motion, and the author has applied his modified theory to Leyden jar discharges, the electrodeless discharges of J. J. Thomson, and the electromagnetic theory of light. In the case of electrodeless discharges in a vacuous globe, it is suggested that the absorption of energy may not only be due to the conductivity of the gas, but also to the inertia which it possesses.—A paper on magnetic precession was then read by the same author. The most delicate method of investigating the influence of electric inertia is based on the electromotive forces introduced by the motion of conductors carrying electric currents. If electricity behaves like a body possessing inertia, the rotation of a body through which currents pass should affect the flow of these currents in the same manner as the earth's rotation affects the direction of currents of air. If the earth's magnetism is due to electric currents, it is interesting to see if the effects of inertia can explain the secular variation. The investigation shows that a magnetic precession of the character of the secular variation would be produced, but that the precession would be very much slower than the variations actually observed. The subject is worked out mathematically, dealing first with the case of currents in a spherical shell, and then extending the result to the case of a solid sphere. The calculated period of a cycle comes out as 7×10^{14} years. If the currents are confined to a thin slice of the earth, the time would be reduced to about 14×10^{6} years. To produce the actual period of the secular change, the current sheet would have to be of molecular dimensions. This suggests the possibility of the phenomenon of secular variation being rather of a molecular than a molar character. Prof. Rücker congratulated the author upon his attempt to solve the problem of terrestrial magnetism, and expressed the hope that further calculation would throw more light upon this difficult subject. Mr. Blakesley asked if the time of the secular variation would be altered if the interior of the earth were liquid or solid. The chairman observed that the precession was rapid in the case of a thin layer of gas, and mentioned J. J. Thomson's notion that the electrons were thrown off by centrifugal force and formed a molecular layer. Hertz, in his experiments on electricity, had looked for material inertia besides electromagnetic inertia. In the present theory the distinction disappears, and there is only one inertia, and that electromagnetic. Prof. Ayrton said if the two forms of inertia were electromagnetic, he would like to know why, in detecting the second form, it was necessary to associate it with an absorption of energy, as in the case of an electrodeless discharge. In the case of ordinary self-induction there is no absorption of energy, and if there is absorption in the second form, and if they are both electromagnetic, he would like to know the difference between the two. Prof. Schuster, replying to Mr. Blakesley, said that if the interior of the earth were treated as liquid, the period of the cycle would be about one hundred times less. In reply to Prof. Ayrton, he said he had only cited one experiment to show that a phenomenon, explained by the gas being a good conductor, could also be explained by its electric inertia. It was impossible to say in general whether self-induction caused an absorption of energy or not.—Prof. A. W. Rücker read a paper on the magnetic field produced by electric tramways. Taking the case of a tramway in which the current flows along a trolley wire from the power-house, and returns partly through the rails and partly as earth currents, the author has shown that the vertical disturbing force at any point is due to the currents in the feeders and rails, and that the earth currents affect the horizontal force only. Experiment shows that it is chiefly the vertical force instruments which are affected by the establishment of an electric railway, and since this disturbance is due to the wires and rails it is impossible for an observatory to be protected by rivers or other natural features of the district. A preliminary investigation is based on the assumption that the trolley wires and rails are insulated conductors, and that a fraction of the whole current returns along the rails to the generator. The effect of the railway at a distant point is due to the difference of the current in the trolley wire and the hypothetical uniform rail current, the effect of which at the point considered is equivalent to the actual rail current, which varies from point to point. It is thus shown that the disturbance increases with the length of the tramway, and for a tramway of given length the disturbance is a maximum at points on a line perpendicular to and bisecting it. Experiments made at Stockton on the magnitude of the disturbing force gave, with the vertical force instrument, a leakage of 16·3 per cent., and with the horizontal force instrument a leakage of 15·9 per cent., a fairly close agreement. The assumption that the terminals of the line are above and below the average potential of the earth by the same amount respectively, and that the leakage at any point is proportional to the potential difference between the rail and the earth, leads to the ordinary theory of a Fourier bar. This more accurate assumption has been developed and applied to the results obtained at Stockton. The leakage, as calculated from the amperes and volts, comes out as 20 per cent. The calculation of the disturbing vertical force gives $10{\cdot}5 \times 10^{-5}$ C.G S. units, which is in fair agreement with the value 7×10^{-5} actually observed. In conclusion, it is pointed out that for practical purposes it is sufficient to deal with the average return current through the rails, the formulæ for which are quite simple.—Dr. R. T. Glazebrook read some notes on the practical application of the theory of magnetic disturbances by earth currents. In this paper the author has thrown the extended formula obtained by Prof. Rücker in the previous paper into a workable form, and has tabulated numbers which show at what distances the disturbances are negligible for tramways of different lengths.—Prof. R. Threlfall exhibited a quartz-thread gravity balance. Prof. Threlfall gave a short description of this instrument, which has been described in full elsewhere. He drew attention particularly to its accuracy and portability. Mr. Simpson asked how far the fibre had been calibrated, and if the instrument would be trustworthy at the freezing-point of mercury. Dr. Glazebrook asked how far the instrument was suitable for Antarctic expedition work. He drew attention to the difficulty of calibrating a new fibre should one get broken in the field. Mr. Appleyard suggested the use of a bath kept at constant temperature with a thermostat. Prof. S. P. Thompson suggested a special meeting to discuss the physics of the Antarctic expedition. Prof. Threlfall said that there was no difficulty in measuring the relation between temperature and coefficient of stiffness down to very low temperatures. A more difficult matter is the coefficient of temperature of the instrument. Shrinkage of the instrument as a whole affects both the fibre and the spring which supports it. The difficulty of a broken fibre in the field can be got over by taking two or three instruments. Working with a thermostat is useful in a laboratory, but decreases the portability in exploration work.—Mr. Watson then exhibited a set of half-seconds pendulums. In these pendulums special attention is paid to the stability of the support. The pendulums are covered by a hood, from which the air can be exhausted so that the logarithmic decrement is diminished. The motion of the pendulums is shown by rays of light reflected from right-angled prisms attached to them, and the period of oscillation is determined by the method of coincidences. For this purpose an accurate astronomical clock is used, and observations are made continuously between two time signals. An accuracy of one part in a million is attainable. In reply to Prof. Threlfall, Mr. Watson said that the knife-edges were on the pendulums, and not on the supports.—The Society then adjourned until January 25, 1901.

CAMBRIDGE.

Philosophical Society, October 29.—The President, Prof. A. Macalister, in the chair.—On the structure and classification of the cheilostomatous polyzoa, by Dr. Harmer. This communication dealt principally with the "compensation-sac," a name given by Jullien to a delicate vesicle lying beneath the front wall of the zooecia of many cheilostomes which have a rigid, calcareous body-wall. This cavity, described by Busk in 1884, and with more accuracy by Jullien four years later, has been looked for in vain or altogether ignored by the majority of recent observers. The compensation-sac is in reality an important organ in lepralioid polyzoa, and Jullien's account of its relations is confirmed.—Observations on the minute structure of the surface ice of glaciers, by Mr. Skinner. By pouring plaster of Paris on the ice surface a permanent cast can be obtained, from which it appears that the porosity of the white superficial layer of a glacier arises from two different causes. The first cause is the melting at the interfaces of the crystalline granules, and the second lies in the formation of small pits by the heat absorbed and radiated from small particles of dust. The two classes of holes are very distinct. Those of the first kind are straight furrows joined to form rough hexagons, and those of the second have a cylindrical or ellipsoidal shape. These pits may occur anywhere on the exposed surface of the crystal, and are like in shape to the larger pits formed by small stones and gravel on the glacier surface. Some other casts have been taken of the surface of the ice formed in ice caverns (glacieres naturelles); these show only the melting at the interfaces and no pits. In the glacières the melting takes place very slowly and is due almost solely to the contact of air only slightly warmer than the melting-point.

November 12.—Prof. Macalister in the chair.—(1) The natives of the Maldives; (2) The atoll of Minikoi, by Mr. J. Stanley Gardiner. The Singhalese and Maldivians appear to be the result of dichotomous branching of a common stem, one division proceeding through the Laccadives to the Maldives, the other travelling to its present home along the west coast of Hindustan. Mr. J. Stanley Gardiner's second paper was taken as read. The atoll of Minikoi is situated on a bank extending down from the west coast of India to the south of the Maldives. The atoll has in the past evidently been raised to a height of at least twenty feet above the sea, before which it consisted of a mere ring-shaped reef awash. The land is now very rapidly being eroded on every side. The lagoon is broadening and deepening, and the reef is markedly growing outwards. The atoll probably grew up as a flat reef on some mound on the sea floor, subsequently attaining its present shape. The numerous deep bands of the Laccadives represent incipient stages in the formation of reefs on such mounds, while the islands and reefs exemplify the changes, which finally produce the perfect atoll.

November 26.—The President, Prof. Macalister, in the chair.—Some experiments on the electrical properties of a mixture of hydrogen and chlorine, when exposed to light, by Prof. J. J. Thomson. A series of experiments were made to see whether there is any production of free ions when a mixture of hydrogen and chlorine is exposed to light. If any such production took place it would cause the electric conductivity of the mixed gases to increase when exposed to light. This was tested by placing a small gold-leaf electroscope inside the mixed gas; the rate of escape of electricity was found not to be affected by exposure to light, either in the stage just after the incidence of the light when the mixture expands, or in the subsequent stages when the hydrogen and chlorine are combining. The problem was then attacked from a different side and free ions produced in the mixture by the aid of Röntgen rays or the radiation from thorium; though large numbers of ions were produced they had no appreciable effect on the rate of combination of the gases.—On the leakage of electricity through dust-free air, by Mr. C. T. R. Wilson.—Elster and Geitel have shown that an electrified body gradually loses its charge when freely exposed in the open air or in a room. Their results are in agreement with previous experiments of Linss. They conclude from their experiments that free ions exist in the atmosphere. The experiments described in this paper prove that ionisation can be detected in a small closed vessel containing dust-free air not exposed to any known ionising agents. To eliminate any uncertainty due to leakage through the insulating supports, the system from which the leakage was measured was fixed by means of a small bead of sulphur to a conducting rod passing through the wall of the vessel and kept at a constant potential equal to the initial potential of the leaking system. To reduce the capacity of the latter to the smallest possible amount, the whole system from which the leakage was measured was reduced to a small brass strip with a narrow gold-leaf attached, the deflections of which, read by means of a microscope, served to measure the potential. With a capacity of ·73 centim. there is a nearly constant fall of potential in a vessel containing 163 c.c. of air at atmospheric pressure, amounting to 3 volts per hour, the initial voltage being 220. The rate of leak is the same in filtered air whether the apparatus be filled and used in the laboratory (where contamination with radio-active substances might be formed) or in the country. The leakage takes place in the dark at the same rate as in diffuse daylight. The rate of leak is the same for positive as for negative charges. The quantity lost per second is the same when the initial potential is 120 volts as when it is 210 volts. Such voltages produce the "saturation" current and the rate of leak may therefore be used to measure the ionisation. The rate of leak is to a first approximation proportional to the pressure; at a pressure of 43 millims. the leakage is about one-fourteenth of that at atmospheric pressure. If we take the value found by Prof. J. J. Thomson for the charge carried by each ion, $6\cdot5 \times 10^{-10}$ E.U., we can take the experiments as indicating that 20 ions of either sign are produced per second in each c.c. of air at atmospheric pressure.—On a solar calorimeter used in Egypt at the total solar eclipse of 1882, by Mr. J. Y. Buchanan. By means of this instrument, which consists of a modified form of a Liebig's condenser mounted equatorially, the solar radiation collected is condensed 48-fold. Observations made with it show that, taking the radius of the earth's orbit to be 212 times the radius of the sun, the radiation of one sq. metre of the sun's surface is spread over 45,000 sq. metres of the earth's surface, whence the sun must radiate energy at the rate of at least 37,300 horse-power per sq. metre of its surface.—Some theorems in regard to matrices, by Mr. T. J. I'A. Bromwich.—On the rational space curve of the fourth order, by Mr. J. H. Grace.—On *Trifolium pratense*, var. *parviflorum*, by Mr. I. H. Burkill.—The writer has been able to examine plants of this so-called variety from Britain and various parts of the Continent, and to show that it is an abnormality in which the carpels are slightly foliaceous, the corolla crumpled, and with a few secondary modifications in other organs.

MANCHESTER.

Literary and Philosophical Society, December 11.—Prof. Osborne Reynolds, F.R.S., Vice-President, in the chair.—On the thermodynamical properties of superheated steam and the dryness of saturated steam, by J. H. Grindley. The paper contained a review of experiments with steam made by various observers. Some calculations were given which showed the fallacy of accepting Regnault's linear law for the total heat and latent heats of evaporation of steam as a basis from which to determine the specific heats and other properties in superheated steam. Useful expressions for the products of the cooling effects and specific heat at constant pressure in steam were given, which would be of use for purposes of comparison with actual experiment. Two alternatives were offered in the paper for the true facts in saturated steam—either Regnault's results on the latent heats of steam can no longer be accepted, or the data deduced from experiments in the superheated condition must be rejected, as they cannot be made to agree.—On a new species of *Sepia* and on other shells collected by Dr. R. Koettlitz in Somaliland, by W. E. Hoyle and R. Standen. The new species of *Sepia* (*S. koettlitzi*) was collected at Zeila, nearly opposite Aden. It is most closely allied to *S. singalensis*, Goodrich, from which it differs in having the chitinous margin on the dorsal surface much narrower, and in the inner cone being flattened and (if anything) rather concave and not convex.

PARIS.

Academy of Sciences, December 10.—M. Maurice Lévy in the chair.—M. Painlevé was elected a member in the section of geometry in the place of the late M. Darboux.—Examination of the habits of bees from the double point of view of mathematics and experimental physiology, by M. Abraham Netter. It has been usually held by entomologists that four of the habits of bees are intentional. The author contests this view, and attempts to show that all the movements of bees, without exception, are of the nature of reflexes, the bees being really small living machines working entirely automatically.—Observations of the Leonids and Bielids made at Athens, by M. D. Eginitis. The observations were much interfered with by the weather. On the 14th November only six meteors were seen, on the 15th thirty-six, on the 16th fifteen only. On November 23 and 24 only thirty-three Bielids were seen, mostly of the fifth and sixth magnitude.—Observations of the sun made at the Observatory of Lyons with the Brunner equatorial during the third quarter of 1900, by M. J. Guillaume. The results of the observations are summarised in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude respectively.—Observations of the Leonids made at Rome on November 14 and 15, by M. Rodriguez. Since no observations of the Leonids were reported by M. Janssen, an account is given of the meteors seen at the Vatican Observatory. Details of 107 Leonids are given, for 17 of which the direction during the time of observation was ascertained.—On limited and integrable functions, by M. Léopold Tejér.—On Neumann's method of the arithmetic mean, by M. W. Stekloff.—On the molecular specific heat of gaseous dissociable compounds, by M. Ponsot. Under constant volume or constant pressure the molecular specific heat of a gaseous compound at infinite dilution is lower than that of the mixture of its elements obtained by dissociation.—On the concentration at the electrodes in a solution, with special reference to the liberation of hydrogen by electrolysis of a mixture of copper sulphate and sulphuric acid, by M. H. J. S. Sand. A formula is developed from theoretical considerations for the concentration of a solution of a single salt round the electrodes after passing a current for a given time. In the case of a mixture the formula gives two limiting values between which the experimental values must lie, and the results of electrolysis of solutions of copper sulphate and sulphuric acid in all cases lie between these extreme values.—On the spectra of samarium and gadolinum, by M. Eug. Demarçay. A discussion of the results obtained on these spectra by M. Exner. The wave-lengths are given for the substance regarded by the author as the purest samarium hitherto obtained.—Action of steam and mixtures of hydrogen and steam upon molybdenum and its oxides, by M. Marcel Guichard. Hydrogen completely reduces the oxides of molybdenum to the metal at a temperature below 600° C. Steam, on the other hand, does not commence to oxidise the metal until a temperature of nearly 700° C. is reached. Oxidation of molybdenum either in steam or in mixtures of hydrogen and steam never gives rise to oxides other than MoO_2 and MoO_3.—Remarks on the note of M. Lemoult entitled "Relations between the chemical constitution of the triphenylmethane dyestuffs and the absorption spectra of their aqueous solutions," by M. Charles Carmichel.—On the primitive form of a crystallised body, by M. Fréd. Wallerant.—Quinone, the active principle of the venom of *Iulus terrestris*, by MM. Béhal and Phisalix. It is shown that the active principle of the poison of *Iulus terrestris* contains a quinone, most probably ordinary quinone.—The venom of the *Scolopendra*, by M. S. Jourdain.—On the osmotic pressure of the blood and internal liquids in the cartilaginous fishes, by M. E. Rodier.—Some results of the Belgian Antarctic expedition, by M. L. Kœhler.—On the endogenous formation of the fungus isolated in cancerous tumours, by M. M. Bra.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 20.

LINNEAN SOCIETY, at 8.—On the Structure and Habits of the *Ammocharidas*: Arnold T. Watson.—The Flora of Vavau, one of the Tonga Islands: J. H. Burkill.—Warning Colours in Insects: Prof. E. B. Poulton, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Lecture on the Electrical Engineers (R.E.) in South Africa: Lieut.-Colonel Crompton.

CHEMICAL SOCIETY, at 8.—On the Union of Hydrogen and Chlorine: J. W. Mellor.

FRIDAY, DECEMBER 21.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Use of Geometrical Methods in investigating Mechanical Problems: C. E. Inglis.

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